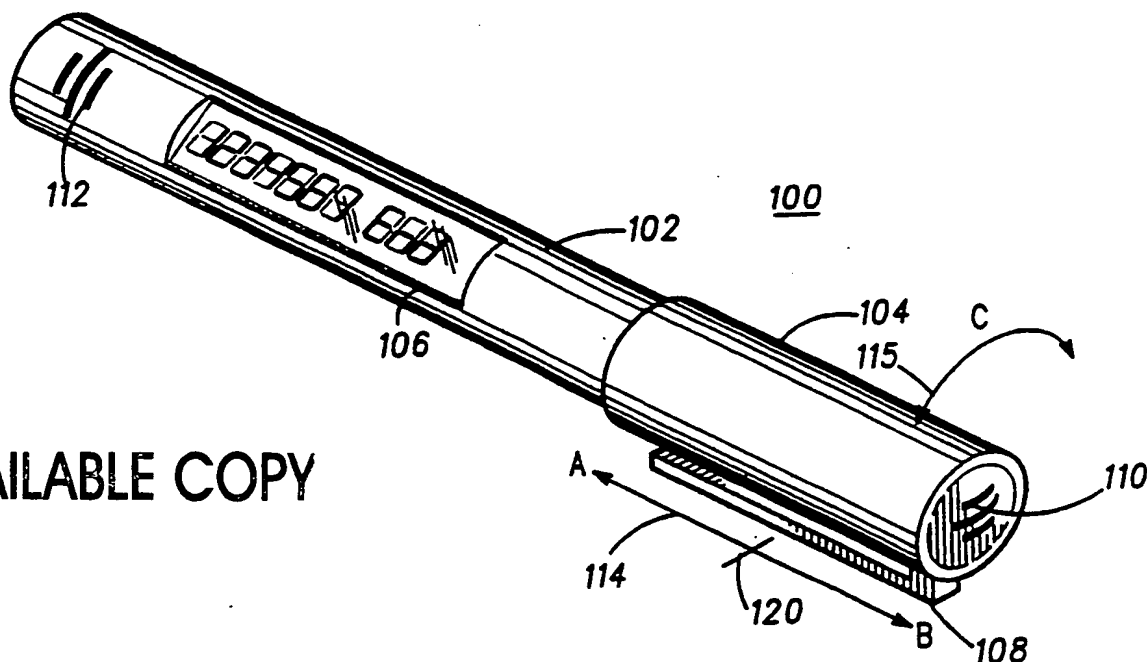


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(54) Title: AN ELECTRONIC APPARATUS HAVING KEYLESS CONTROL



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## (57) Abstract

The method and apparatus of the present invention permits data entry in an electronic apparatus without using a keypad. By rotating a moveable element (104), a function, letter, or number is selected. The moveable element (104) is then moved in another direction to enter the selected item. The function, letter, or number can be displayed on a display (106), announced with a synthesized voice, or displayed and announced.

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## AN ELECTRONIC APPARATUS HAVING KEYLESS CONTROL

### Field of the Invention

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The present invention relates generally to data entry for a keyless electronic device.

### Background of the Invention

10

A wireless communications apparatus, of which a portable cellular radiotelephone subscriber unit is a convenient example, provides an appropriate setting for describing the need for the present invention. There is essentially one known technique for controlling a radiotelephone. The technique uses from two to twelve function keys in addition to the standard twelve key data pad and it includes a display for the data input.

The function keys generally include some or all of the following functions: send, end, power, recall, store, clear, function, name, volume, and menu. The number and type of keys depends on the manufacturer and the features on the phone.

Functions which are essential to the operation of the phone include send, end, power, and clear. The send function initiates a phone call to the number entered with the data keys and located in the display and also answers an incoming phone call. The end function terminates a phone call. The power function turns the radiotelephone on and off. The clear function is used when entering data to clear either one character of data or the entire display of data.

There are usually dedicated keys that store and recall names and phone numbers to and from the radiotelephone memory, namely, the store key, the recall key, and the name key. The store key stores data into a memory location. First, the data is entered into the radiotelephone with the data keys,

then the store key is pressed, followed by a memory location entered with the data keys. This data can be either symbols representing names or numbers representing telephone numbers. The recall key followed by an appropriate memory  
5 location recalls the telephone number or name contained within that memory location. The name key activates a menu of names that have phone numbers corresponding to them. The user then scrolls through the menu of names using the “#” and the “\*” keys. The “#” key scrolls through the names  
10 in one direction and the “\*” key in the other.

Other keys that activate various features of the phone may vary between manufacturers. The function key may activate other features of the phone denoted by the number input with the data keys that follow activation of the function key.  
15 Finally, the menu key may access a menu of advanced features that can be scrolled through using the “#” and the “\*” keys.

A typical radiotelephone that uses a keypad similar to the one described above is the DYNA T-A-C cellular radiotelephone. A description of its operation is found in  
20 Motorola user manual number 68P81066E40, “DYNA T-A-C Cellular Mobile Telephone 800MHZ Transceiver” or the portable transceiver shown and described in Motorola user manual number 68P81054E60, “DYNA T-A-C Cellular  
25 Portable Telephone G-Series”. Both documents are published by and available from Motorola C & E Parts, 1313 East Algonquin Road, Schaumburg, Illinois 60196.

These functions on radiotelephones have historically been implemented with a plurality of buttons or keys disposed  
30 on the apparatus or a keypad. With the reduction in the size of the radiotelephone and the resulting size reduction of the keypad to a size that is not easily usable, there is a resulting need for an improved technique for operating a radiotelephone without the use of a keypad.

35

### Summary of the Invention

The present invention encompasses a method for operating an electronic apparatus. The apparatus has a plurality of function, memory and a moveable element. The moveable element can rotate around and slide in a first and second direction along a longitudinal axis extending through the apparatus. The method comprises the steps of rotating the moveable element to select a first function from the plurality of function then initiating the first function by sliding the moveable element in the first direction along the longitudinal axis.

### Brief Description of the Drawings

1 5

FIG. 1 shows an electronic device in accordance with the present invention.

FIG. 2 shows the display and indicators used in the electronic device of the present invention.

2 0

FIG. 3 shows a block diagram of the radiotelephone of the present invention.

FIG. 4 shows a timing diagram of the present invention.

2 5

FIG. 5 shows an alternate embodiment of the display of the present invention.

FIG. 6 shows a flow chart of a method of the present invention.

### Detailed Description of the Preferred Embodiment

3 0

A portable electronic device 100 is shown in FIG. 1. In the preferred embodiment, this device is a radiotelephone for use in a cellular radiotelephone system. The radiotelephone 100 includes a display 106 on the side of the unit, an earpiece 110 at one end and a microphone 112 at the opposite end of the unit, and a moveable element or end cap 104. A clip 108 is

used to keep the apparatus from falling out of one's pocket, similar to the function of a clip on a conventional writing pen. This clip 108 also permits easier rotation of the end cap 104.

Referring to FIG. 1, the moveable end cap 104 rotates in  
5 direction 115 around one axis 114 and slides in and out in the A and B directions, from a neutral rest position 120, along the same axis 114. All movements of the end cap 104 are with respect to main body 102. The end cap 104 experiences a number of detents or clicks as it is rotated to give feedback to  
10 the user. As discussed later, the motion of the end cap 104 is used to enter data to be used by the radiotelephone 100 in addition to controlling power.

The display 106 provides visual feedback for these user entries. In the preferred embodiment, alphanumeric characters are entered and displayed. In alternate embodiments,  
15 other symbols may be substituted, such as Japanese katakana. These alternate symbols are described in U.S. Patent Number 4,872,196, issued on October 3, 1989 to Paul Royer et al. and assigned to Motorola Inc.

FIG. 2 illustrates the display 106 that may be used in  
20 accordance with the present invention. The display is comprised of several sections. Characters in section 202 are used to display the desired telephone number, name, or status of the device during operation. Characters in section 204 are  
25 used to display various menus for the user interface. Indicators 206, 208, and 210 display unit status such as "IU" when the radiotelephone is in use, "NS" when the radiotelephone is experiencing no service, or "RM" when the radiotelephone is roaming outside its home service area. The display 106 can be a liquid crystal display.  
30

FIG. 3 shows a schematic block diagram of the radiotelephone 100 incorporating the present invention. The transceiver 301 communicates to another transceiver such as a cellular base station. Microphone 112 and speaker 110 provide audio input and output for the transceiver. A micro-  
35 computer 303 controls transceiver 301 functions and the user

interface. Memory 305 is used to store telephone numbers and alphanumeric name tags for the dialing repertory. This memory 305 can be part of the microcomputer or separate from the microcomputer.

5        Three switches 307, 309, and 311, connected to the microcomputer 303, sense the direction of rotation 115 of the end cap 104 and movement of cap 104 in direction 114A. A fourth switch 313 is used to turn the power supply controller 315 of apparatus 100 on and off by movement in direction 114B.  
10    The battery 317 provides the power source for the apparatus.

      The power to the radiotelephone is controlled in a momentary switch fashion by the power switch 313. By pulling the end cap 104 momentarily in direction 114B a first time, the power switch 313 is momentarily closed activating the power  
15    supply controller 315 thus supplying power to the radiotelephone. When the end cap 104 is pulled momentarily in direction 114B a second time, the power switch 313 is again momentarily closed, deactivating the power supply controller 315 thus removing power from the radiotelephone. This type  
20    of switch operation is described in more detail in U.S. Patent No. 4,798,975 to Walczak et al. and assigned to Motorola Inc. Direction 114B was chosen as the power activation direction in order to avoid inadvertently turning the radiotelephone on. If the user was placing the radiotelephone in their pocket,  
25    pushing down on the end cap 104 would have no effect on the power.

      FIG. 4 illustrates the timing diagram associated with switches 307 and 309. A logic high, in the preferred embodiment of the present invention, is +5V and a logic low 0V.  
30    Alternate embodiments may use different voltages to denote logic highs and lows. Each dotted line in FIG. 4 designates the location of a detent for the movement of the end cap 104. For the purposes of this discussion, the following end cap rotations start at detent 401. Rotating the end cap element 104  
35    in a clockwise direction results in switch 307 closing prior to switch 309. Rotating the end cap 104 in a counter-clockwise

direction results in switch 309 closing prior to switch 307. The microcomputer 303, sensing the levels on switches 307 and 309, determines which direction and how many closures of each switch have occurred.

5           The rotation of the end cap 104 causes the menu to scroll thus displaying the menu items on display section 204. When the user sees a desired menu item on display section 204, the end cap 104 is momentarily pressed in direction 114A, momentarily closing switch 311 and selecting that particular  
10       menu selection. The operation of the end cap 104 is illustrated in the examples. All menus are of the "rotary file" type in that they wrap around. An example being that when the last menu item is reached, the next menu item displayed is the first menu item.

15           Should one of the switches 307 or 309 fail in an open condition, the radiotelephone will still function in a fail safe manner but menus will only scroll in one direction. Slow rotation of cap 104 will result in the user seeing every item in the current menu in the display. Fast rotation of cap 104 will  
20       result in skipping of certain menu items being displayed.

          Certain menu items must be skipped during fast rotation of the end cap 104 due to two factors. First, the display cannot keep up with an end cap 104 that rotates too quickly. This will cause a backlog of data to be displayed even after the  
25       end cap 104 has stopped rotating. Second, the end cap 104 rotating quickly indicates that the user wishes to progress through a large number of menu items rapidly to reach a menu item that is known to be further down the menu.

          If the microcomputer 303 senses that the rotation of the  
30       end cap has exceeded the systems ability to display all the menu items, the microcomputer 303 will display only every 5th item in the preferred embodiment. Alternate embodiments can skip a greater number of items or a lesser number.

35           As an example of rapid entry, if the user is entering a name and is presently on the letter L of a menu containing the letters A through Z, the rapid rotating of the end cap 104 will cause the letter Q to be displayed next. This feature will



speed up the users ability to operate the apparatus after becoming used to the menus while still keeping track of the location in the menu. Once the approximate location in the menu has been found, the user returns to slow turning of the end cap 104, in direction 115, to find the proper menu item.

At any point in time when entering a sequence of data, it may be necessary to clear the last input or the entire data input, depending upon how severe the mistake. This is accomplished by use of the CLR selection in the menus. By pushing the end cap 104 in direction 114A and quickly releasing, only the last entry will be cleared. By pushing the end cap 104 in direction 114A and holding for a short time, the entire entry is cleared.

To better illustrate the operation of the end cap 104 in controlling the radiotelephone, seven examples have been provided. FIG. 6 shows a flow chart of an additional method for entering a name and associated number to be stored in the memory 305. Alternate embodiments may vary from these examples in the order of data entry or menu items.

EXAMPLE 1:

(Unit is locked and User LOCK Code is "3,9,5")

5 Turn on unit by pulling outward on end cap 104. The "LOCKED" menu appears when the unit is turned on and the unit was previously locked to prevent unauthorized use. The user inputs the lock code as follows. Note that blank characters in the display are shown as *b*.

10	LOCdbbb	0bb	Initial display when unit is locked.
	LOCdbbb	1bb	User scrolls clockwise through 1, 2, and 3.
	LOCdbbb	2bb	User scrolls clockwise through 1, 2, and 3.
	LOCdbbb	3bb	User scrolls clockwise through 1, 2, and 3.
	3bbbbb	3bb	User pushed in on cap to select 3.
15	3bbbbb	4bb	User scrolls clockwise through 4, 5, 6, 7, 8, and 9.
	3bbbbb	5bb	"
	3bbbbb	6bb	"
	3bbbbb	7bb	"
20	3bbbbb	8bb	"
	3bbbbb	9bb	"
	39bbbbb	9bb	User pushed in on cap to select 9.
	39bbbbb	8bb	User scrolls counter clockwise
	39bbbbb	7bb	through 8, 7, 6, and 5.
25	39bbbbb	6bb	"
	39bbbbb	5bb	"
	ONbbbbb	RCL	User pushes in on cap to complete lock code and unlock unit. "ON" menu is now used.

30

The user could have made selections by rotating the cap only in the clockwise direction. Had a mistake been entered, then the "CLR" function on the "LOCKED" menu could be used to clear the last entry.

35

"LOCKED" MENU: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, CLR

**EXAMPLE 2:**

(User enters phone number 576-2600 and places a call)

5 The user inputs the phone number and initiates a call as follows. Note that blank characters in the display are shown as *b*. The "ON" menu appears when the unit is on and not in the locked mode.

	ONbbbb	RCL	Initial display when turned on.
1 0	ONbbbb	SND	User scrolls clockwise through SND,
	ONbbbb	NAM	NAM, 1, 2, 3, 4, and 5.
	ONbbbb	0bb	"
	ONbbbb	1bb	"
	ONbbbb	2bb	"
1 5	ONbbbb	3bb	"
	ONbbbb	4bb	"
	ONbbbb	5bb	"
	5bbbbbb	5bb	User pushed in on cap to select 5.
	5bbbbbb	6bb	User scrolls clockwise through 6 & 7.
2 0	5bbbbbb	7bb	"
	57bbbb	7bb	User pushed in on cap to select 7.
	57bbbb	6bb	User scrolls counter clockwise to 6.
	576bbbb	6bb	User pushed in on cap to select 6.
	576bbbb	5bb	User scrolls counter clockwise
2 5			through 5, 4, 3, and 2.
	576bbbb	4bb	"
	576bbbb	3bb	"
	576bbbb	2bb	"
	5762bbb	2bb	User pushed in on cap to select 2.
3 0	5762bbb	3bb	User scrolls clockwise through 3, 4,
			5, and 6.
	5762bbb	4bb	"
	5762bbb	5bb	"
	5762bbb	6bb	"
3 5	57626bb	6bb	User pushed in on cap to select 6.

	57626bb	5bb	User scrolls counter clockwise through 5, 4, 3, 2, 1, and 0.
	57626bb	4bb	"
	57626bb	3bb	"
5	57626bb	2bb	"
	57626bb	1bb	"
	57626bb	0bb	"
	576260b	0bb	User pushed in on cap to select 0.
	5762600	0bb	User pushed in on cap to select 0 again.
10	5762600	NAM	User scrolls counter clockwise through NAM, RCL, and SND.
	5762600	SND	"
	ONbbbbbb	END	User pushed in on cap to select SND to initiate a call.
15	ONbbbbbb	RCL	When the user finished talking, user pushed in on cap to select END to end the call.
20	<u>"ON" MENU:</u> RCL, SND, NAM, 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, *, #, END, CLR, VOL, STO		

EXAMPLE 3:

(User recalls a phone number from memory location 37 and places a call. Memory location 37 contains phone number 123-4567.)

5

The user recalls the phone number and initiates a call as follows. Note that blank characters in the display are shown as *b*. The

1 0	ON <b>bbbb</b>	RCL	Initial display when turned on in "ON" menu.
	RCL <b>bbbb</b>	0 <b>bb</b>	User pushed in on cap to select RCL.
	RCL <b>bbbb</b>	1 <b>bb</b>	User scrolls clockwise through 0, 1, 2, and 3.
1 5	RCL <b>bbbb</b>	2 <b>bb</b>	"
	RCL <b>bbbb</b>	3 <b>bb</b>	"
	RCL <b>b3bb</b>	3 <b>bb</b>	User pushed in on cap to select 3.
	RCL <b>b3bb</b>	4 <b>bb</b>	User scrolls clockwise through 4, 5, 6, and 7.
2 0	RCL <b>b3bb</b>	5 <b>bb</b>	"
	RCL <b>b3bb</b>	6 <b>bb</b>	"
	RCL <b>b3bb</b>	7 <b>bb</b>	"
	RCL <b>b37b</b>	7 <b>bb</b>	User pushed in on cap to select 7.
	1234567	SND	Phone # from location 37 is displayed and "ON" menu is set to SND in preparation to initiate a call.
2 5			
	ON <b>bbbb</b>	END	User pushed in on cap to select SND and initiate a call. "ON" menu is set to END in preparation to terminate the call when the user is finished talking.
3 0			

**EXAMPLE 4:**

(User recalls a phone number from memory by alpha tag and places a call. Memory contains alpha tags: )

5	...	CHRIS	
		DALE	
		DAVE	
		DOUG B	
		ERIC	...
10	The user recalls the phone number and initiates a call as follows. The blank characters in the display are shown as b. The "NAME" menu appears when the "NAM" function is selected via the "ON" menu. It is used when recalling phone		
15	numbers from memory that have associated alpha name tags.		
	ONbbbbbb	NAM	User scrolls through "ON" menu to NAM.
20	NAMEbbb	Abb	User pushed in on cap to select NAM function. Menu changes to NAME menu and starts at "A".
	NAMEbbb	Bbb	User scrolls through B, C, D.
	NAMEbbb	Cbb	"
	NAMEbbb	Dbb	"
25	DALEbbb	bbb	User pushed in on cap to select "D". Names are displayed in alphabetical order starting with the first name beginning with the letter "D".
	DAVEbbb	bbb	User scrolls to desired name.
30	DOUGbBb	bbb	"
	DOUGbBb	SND	User pushes in on cap to select "DOUG B". Menu returns to "ON" menu set to SND.
35	ONbbbbbb	END	User pushes in on cap to select SND and initiate the call.
	<u>NAME MENU:</u> A, B, C, ..., X, Y, Z, END, CLR		

**EXAMPLE 5:**

(User enters phone number 576-2600 and stores it in memory location 25.)

5           The user inputs the phone number and initiates a call as follows. Note that blank characters in the display are shown as *b*. The "STORE" menu appear when the 'STO' function is selected via the "ON" menu. The "STORE" menu is used when storing a telephone number into memory.

10           ON**bbbb**    RCL           Initial display when unit is turned on. User enters the number from example 2.

15           5762600    0**bb**  
               5762600    NAM           User scrolls through "ON" menu to STO.

              5762600    SND  
               5762600    RCL

20           5762600    STO  
               STO**bbbb**    0**bb**           User pushes in on cap to select STO function.

              STO**bbbb**    1**bb**           User scrolls through STO menu to "2".

25           STO**bbbb**    2**bb**  
               STO**b2bb**    2**bb**           User pushes in on cap to select "2".  
               STO**b2bb**    3**bb**           User scrolls through STO menu to "5".

              STO**b2bb**    4**bb**  
               STO**b2bb**    5**bb**

30           STO**b25b**    END           User pushes in on cap to select "5". Menu returns to "ON" menu set to END.

35    STORE MENU: \*, 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, END, CLR

**EXAMPLE 6:**

(User increases earpiece volume by two levels out of seven from level four to level six.)

5           The user inputs the phone number and initiates a call as follows. Note that blank characters in the display are shown as *b*. The "VOLUME" menu appears when the 'VOL' function is selected via the "ON" menu. The "VOLUME SELECT" menu appears when either the 'EAR' or 'RNG' functions are selected via the "VOLUME" menu. The "VOLUME SELECT" menu has seven volume levels as well as the end function.

15	ON <b>bbbb</b>	VOL	User scrolls through "ON" menu to VOL function.
	VOL <b>bbbb</b>	EAR	User pushes in on cap to select VOL. Menu changes to VOL menu starting at EAR.
20	8888 <b>bb</b>	EAR	User pushes in on cap to select earpiece volume. Display indicates unit is presently at level four by the four characters displayed.
	8888 <b>bb</b>	EAR	User scrolls clockwise to increase level to six.
25	888888 <b>b</b>	EAR	
	ON <b>bbbb</b>	VOL	User pushes in on cap to select level six and menu returns to "ON" menu.

30           In a similar manner, the ringer (RNG) volume level could be selected and changed. Volume increases with clockwise rotation and decreases with counter-clockwise rotation of the end cap 104. The user can select END to exit the volume menu without making a change.

35

VOLUME MENU: EAR, RNG, END



VOLUME SELECT MENU: 8888888, 8888888, 8888888, 8888888,  
8888888, 8888888. 8888888,  
END8888

**EXAMPLE 7:**

(Incoming call.)

5       When the phone rings indicating an incoming call, the menu returns to the "ON" menu set at SND so that the user need only push in on the cap to answer the call.

10       While the preferred embodiment of the present invention has been illustrated using a radiotelephone, alternate embodiments can replace the radiotelephone by other electronic devices that are too small to use a normal keypad. These include, but are not limited to pagers, radios, calculators, electronic organizers, etc.

15       The preferred embodiment uses the display 106 to indicate modes, alphanumeric characters, and symbols. An alternate embodiment uses voice feedback generated by the microcomputer 303 that has a built-in digital to analog converter 330 and output using the speaker 110. In this embodiment, the method of rotating the moveable element is the same as in the preferred embodiment while the modes and numbers that are selected are announced with a synthesized voice instead of the display 106. Another alternate embodiment uses both the display 106 and the synthesized voice. The voice feedback would allow visually impaired users to operate the apparatus.

20       An alternate embodiment of the present invention, illustrated in FIG. 5, can use two displays in place of the single display 106. In this embodiment, smaller three digit display is used to display the menu item while a larger display indicates the names or numbers.

25       By using the methods and apparatus of the present invention, an electronic device's size is not limited by the buttons or keypad. This reduces the size, weight, and the manufacturing cost thereby reducing the actual cost of the item.

Claims

1. A method for operating an electronic apparatus, the apparatus having a plurality of functions, memory and a  
5 moveable element, the moveable element having the ability to rotate around and slide in a first and second direction along a longitudinal axis extending through the apparatus, the method comprising the steps of:  
rotating the moveable element to select a first function  
10 from the plurality of functions; and  
initiating the first function by sliding the moveable element in the first direction.
2. The method of claim 1 and further including the  
15 step of selecting a sequence of operations representing a telephone number.
3. The method of claim 1 and further including the  
20 step of selecting a sequence of operations representing a memory location within the memory of the electronic apparatus.
4. The method of claim 1 wherein the first function is  
25 displayed on a liquid crystal display.
5. A method for programming a radiotelephone with a telephone number and a name, the radiotelephone having memory, a plurality of functions, and a moveable element, the moveable element having the ability to rotate around and  
30 slide in a first and second direction along a longitudinal axis extending through the apparatus, the method comprising the steps of:  
rotating the moveable element to select a number entry function of the plurality of functions;  
35 sliding the moveable element in the first direction to enter the number entry function;

rotating the moveable element to select a first number  
of the telephone number;  
sliding the moveable element in the first direction to  
enter the first number;  
5 repeating from the previous two steps until the tele-  
phone number has been entered;  
rotating the moveable element to select a name entry  
function of the plurality of function;  
sliding the moveable element in the first direction to en-  
1 0 ter the name entry function;  
rotating the moveable element to select a first letter of  
the name;  
sliding the moveable element in the first direction to en-  
ter the first letter of the name;  
1 5 repeating the previous two steps until the name is en-  
tered;  
rotating the moveable element to select a store function  
from the plurality of functions; and  
sliding the moveable element in the first direction to  
2 0 store the name and the number.

6. A radiotelephone device for communicating in a cel-  
lular radiotelephone system, a longitudinal axis extending  
lengthwise through the device, the device comprising:  
2 5 transmitting means for transmitting radiotelephone  
signals;  
receiving means for receiving radiotelephone signals;  
processing means for controlling the radiotelephone  
device;  
3 0 memory, coupled to the processing means, for storing  
data;  
a display for displaying data from the memory; and  
a movable element, that rotates around and slides in a  
first and second direction along the longitudinal axis, for se-  
3 5 lecting data from the memory to be displayed.

7. A radiotelephone device for communication in a cellular radiotelephone system, a longitudinal axis extending lengthwise through the device, the device comprising:

- transmitting means for transmitting radiotelephone  
5 signals;
- receiving means for receiving radiotelephone signals;
- processing means for controlling the radiotelephone  
device;
- memory, coupled to the processing means, for storing  
10 data;
- means, coupled to the processing means, for convert-  
ing data from the memory to a voice signal; and
- a movable element, that rotates around and slides in a  
first and second direction along the longitudinal axis of the  
15 device, for selecting data from the memory to be announced by  
the voice signal.

8. A method for operating an electronic apparatus, the apparatus having a plurality of functions, memory and a  
20 moveable element, the moveable element having the ability to rotate around and slide along a longitudinal axis extending through the apparatus, the method comprising the steps of:
- rotating the moveable element to select a first function  
from the plurality of functions; and
  - 25 initiating the first function by sliding the moveable ele-  
ment.

9. The method of claim 8 and further including the  
step of selecting a sequence of operations for initiating a  
30 telephone call.

10. The method of claim 8 and further including the  
step of selecting a sequence of operations for answering a  
telephone call.

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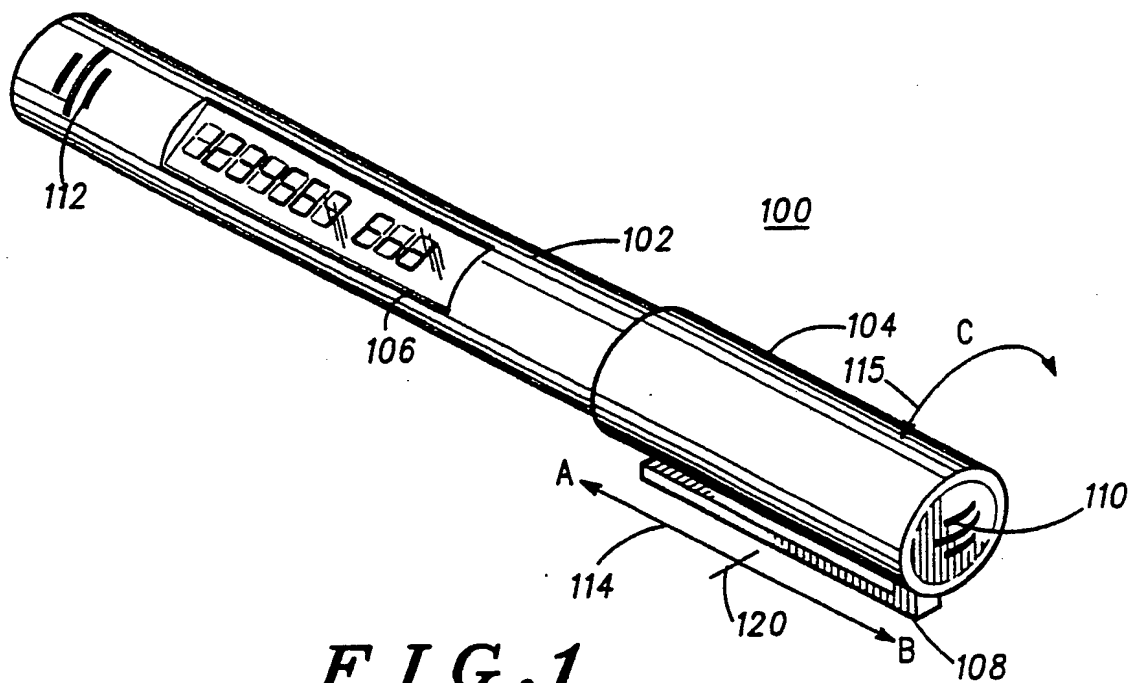


FIG. 1

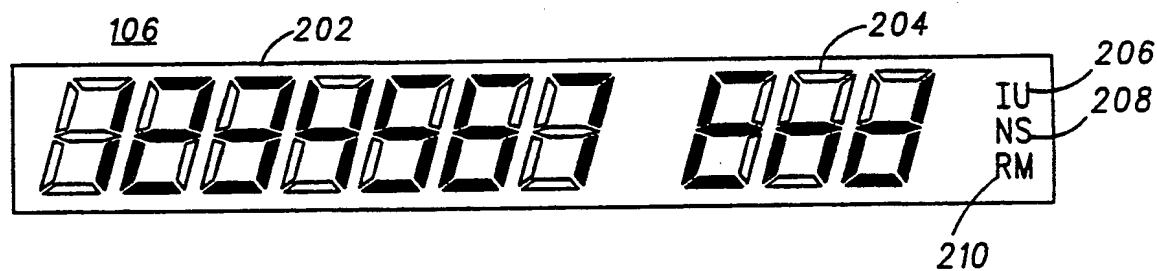


FIG. 2

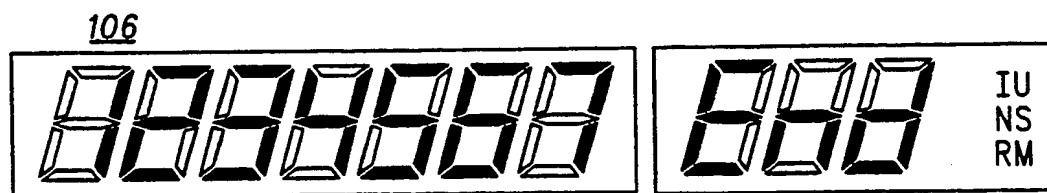


FIG. 5

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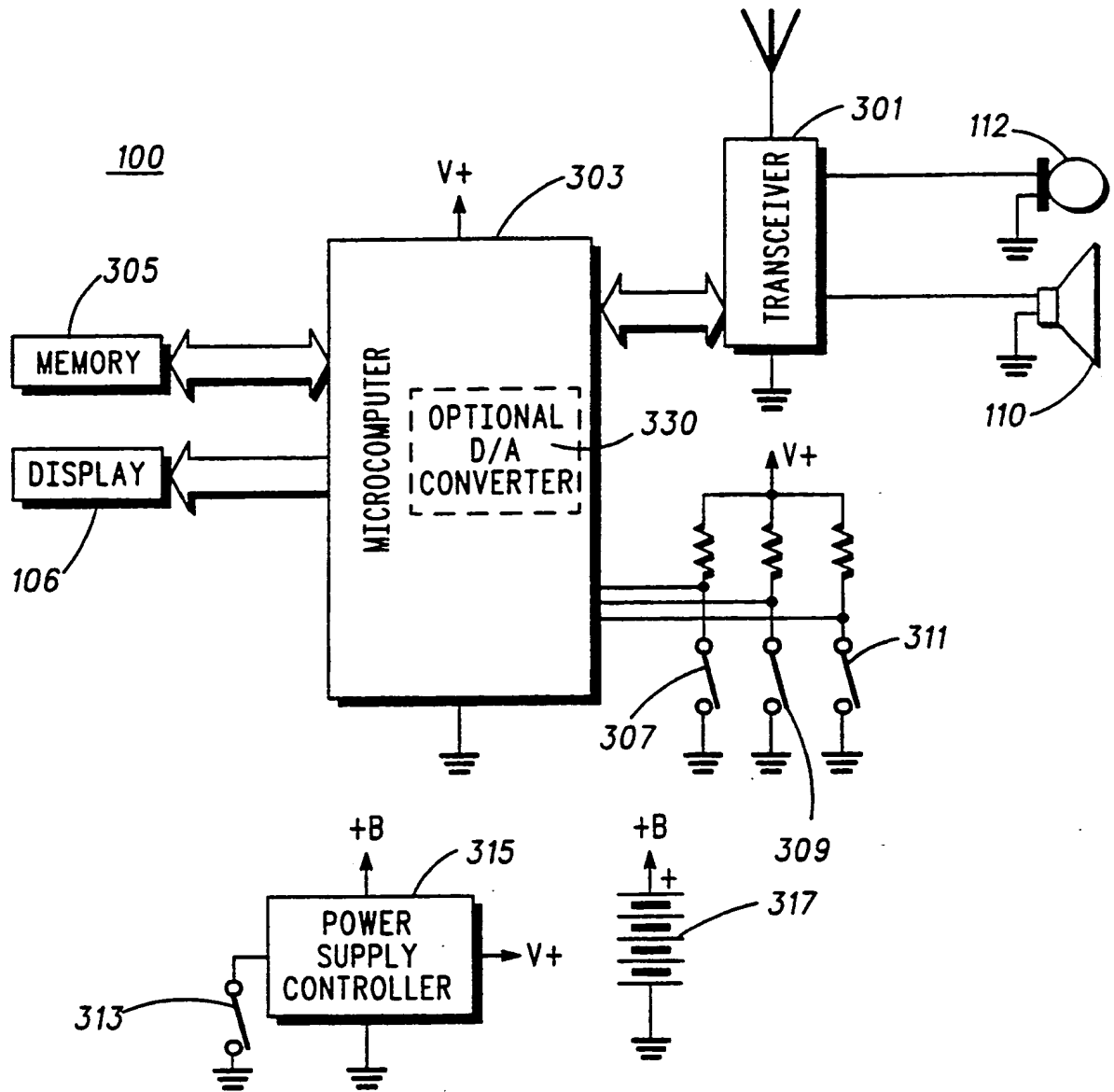


FIG. 3

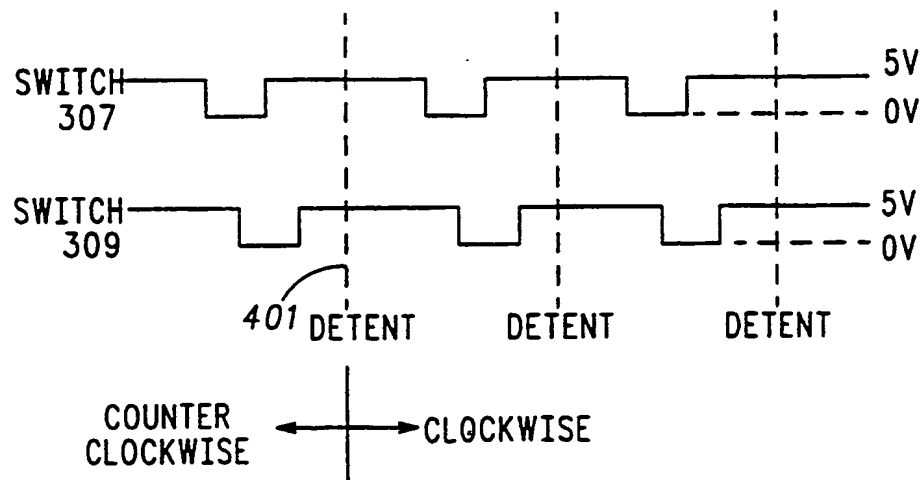
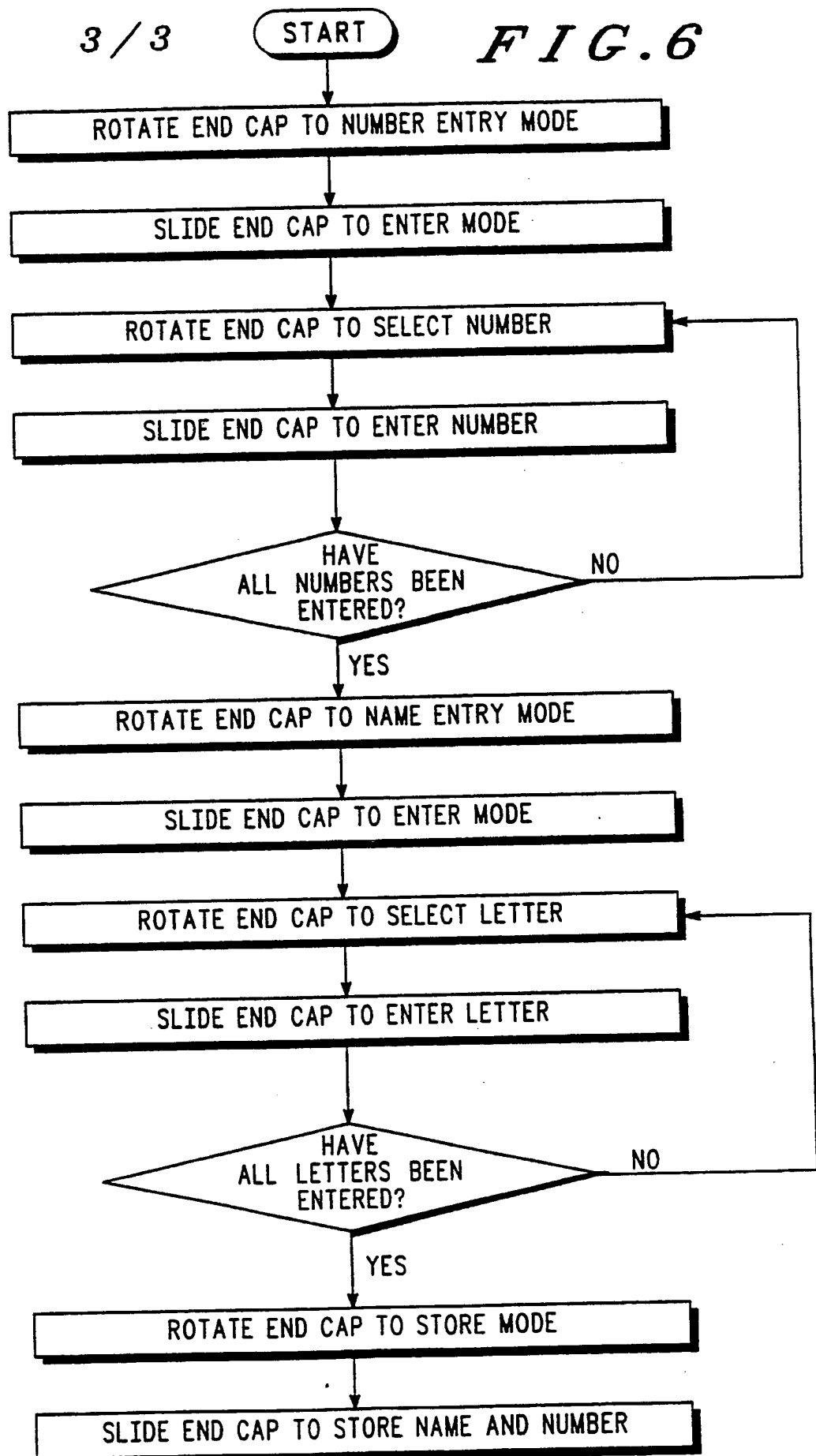


FIG. 4

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START

FIG. 6





## INTERNATIONAL SEARCH REPORT

CT/US92/08436

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(5) :H04M 11/00

US CL :379/58

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 379/56, 61, 67, 88, 90, 110, 280, 350, 354, 355, 356, 419, 428, 434; 379/58

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

APS-USPAT: direction, electronic, functions, rotate, rotating, longitudinal axis, moveable element

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US, A, 4,682,357 (Iriño) 21 July 1987	5-7
A	US, A, 4,674,111 (Monet et al) 16 June 1987	5-7
A	US, A, 4,847,818 (Olsen) 11 July 1989	5-7
A	US, A, 4,969,180 (Watterson) 06 November 1990	5-7
A	US, A, 5,042,063 (Sakanishi et al) 20 August 1991	5-8
A	US, A, 5,054,051 (Hoff) 01 October 1991	5-7

☐ Further documents are listed in the continuation of Box C.☐ See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

01 DECEMBER 1992

Date of mailing of the international search report

04 JAN 1993

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